Military Utility: Generating Relevant Criteria For Systems Design, Testing, and Analysis

Dr. Paul H. Deitz, Technical Director

U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-TD
Aberdeen Proving Ground, MD 21005-5071
(410) 278-6598, DSN 298-6598;phd@arl.mil
http://amsaa-web.arl.mil/OTD/techdir.html

28 March 2000

Presented at the 11th Annual U.S. Army Ground Vehicle Survivability Symposium, held at the Naval Post Graduate School, Monterey, CA, March 27-30, 2000.

Objective of Paper

- To present a kind of operational architecture suitable for integrated weapons analysis
- To see how the elements change as a mission progresses
- To see how the structure must be built from the desired mission outcome back towards platform design
- To extend the process to a system-of-systems

Key Metrics

There are three principal weapons platform metrics:

Level 4], *Platform Utility,* which is derived from

Level 3], *Platform Capability,* which is derived from

Level 2], *Platform Componentry/Connectivity,* which is the fundamental platform metric

Key Platform Metrics

These metrics are the

WHY, (Level 4])

the

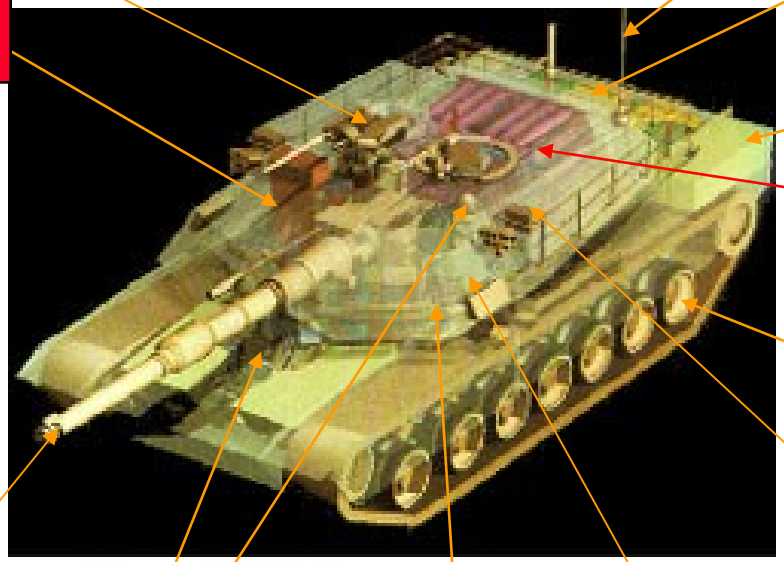
WHAT, (Level 3])

and the

HOW (Level 2])

of an *operations research* framework.

Example: Platform Configuration [Level 2]



Secondary Armament

Early Warning Sensors (LWR, RWR, MWR)

Move

Shoot

Communicate

Commo Equipment

Engine Compartment

Fuel

Ammo Compartment

Wheels/Track

Commo Equipment

Target Acquisition/Engagement Sights

Main Armament

Crew

Millimeter Wave Radar Antenna

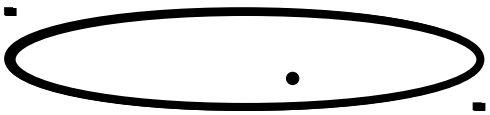
AMSAA

Abstraction: Platform Configuration Level 2]

Military Operations Context

- Tactics
- Doctrine
- Scenario
- etc. (Global Variables)

Level 2]



$v_2[C_1, C_2, \ldots, C_c, C_d, \ldots, C_i, C_k, \ldots, C_m, C_n]$

Crew Ammo Fuel Msn Crit

Re-Armed and Re-Fueled

H + 7

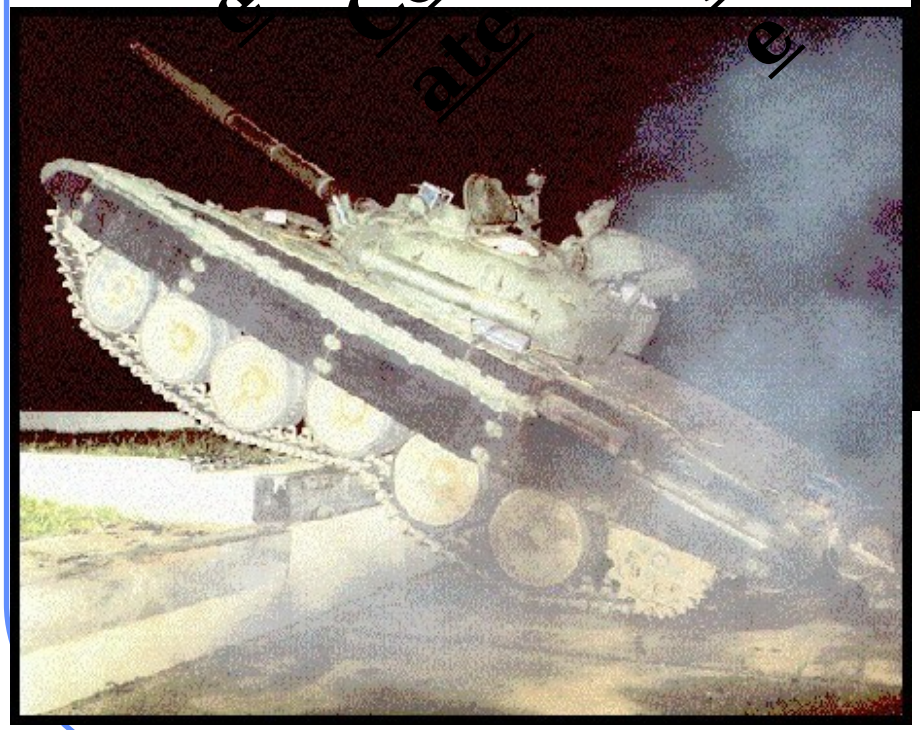
Testing for Platform Capabilities

Level 3]

Move

Communicate

Sense



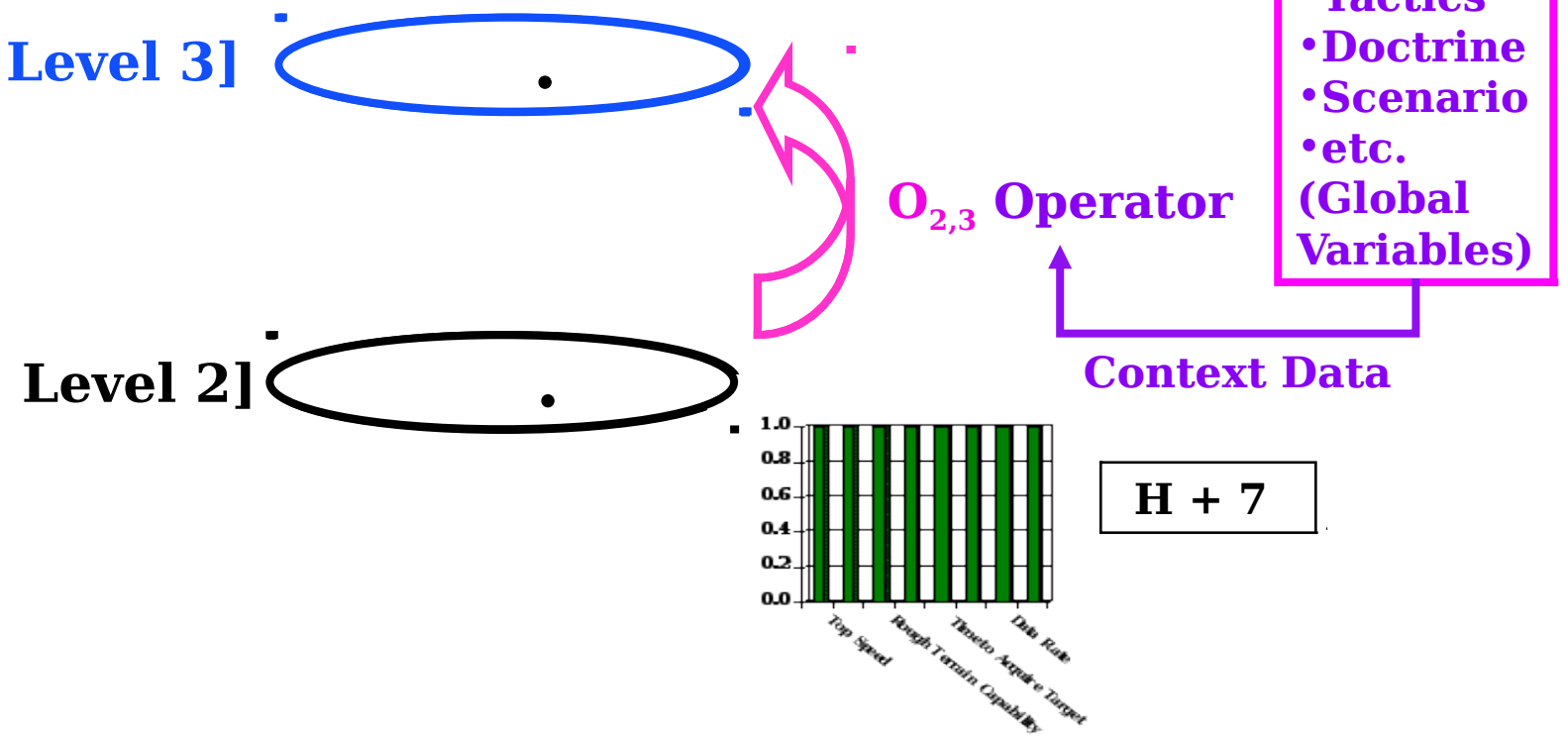
Engage

Replenish

AMSAA

Abstraction: Platform Capabilities [Level 3]

v_3[Top Speed, Max Range, Rough Terrain C[illegible]ability, ... litary
Rate of Fire, Time to Acquire Tgt, Hit D[illegible]spersion, ... eratio
Data Rate, Data Latency, ...]



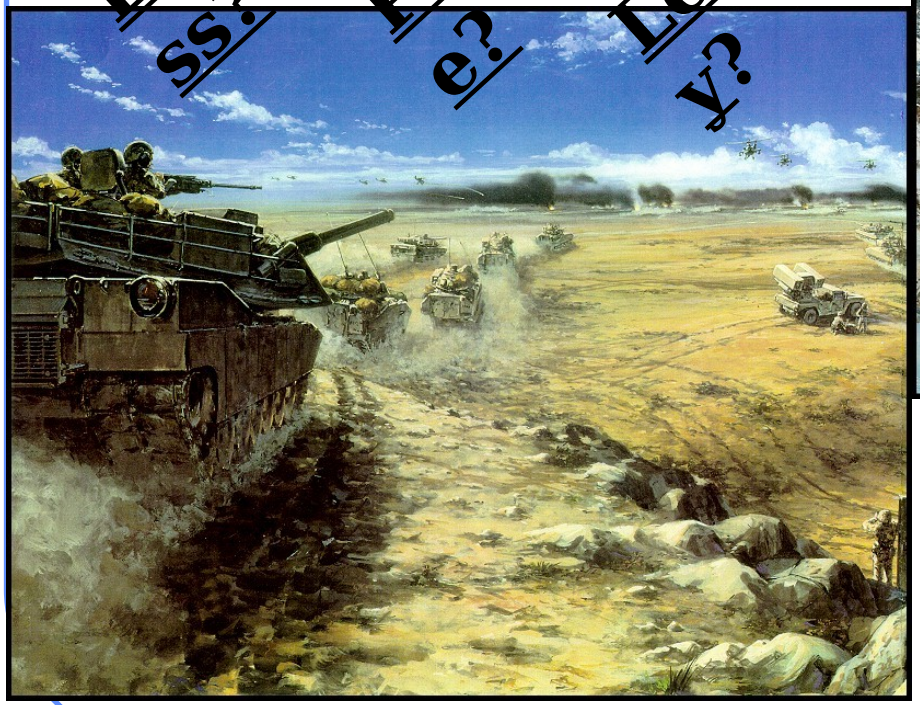
Mission Utility from Capabilities

Level 4]

Effectiveness?

Performance?

Lethality?



Survivability?

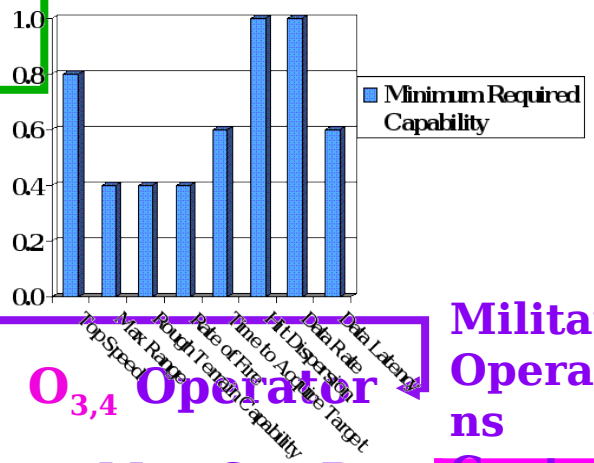
Loss/Exchang

Readiness?

AMSAA

Abstraction: Platform Utility

Level 4]



Level 4]

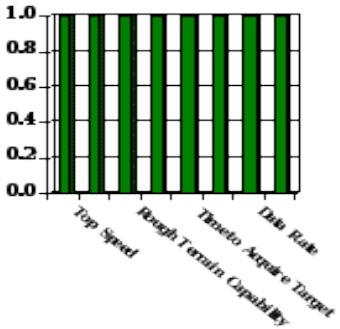
$O_{3,4}$ Operator

Msn Cap Reqs

Military Operations Context

- Tactics
- Doctrine
- Scenario
- etc.

(Global Variables)

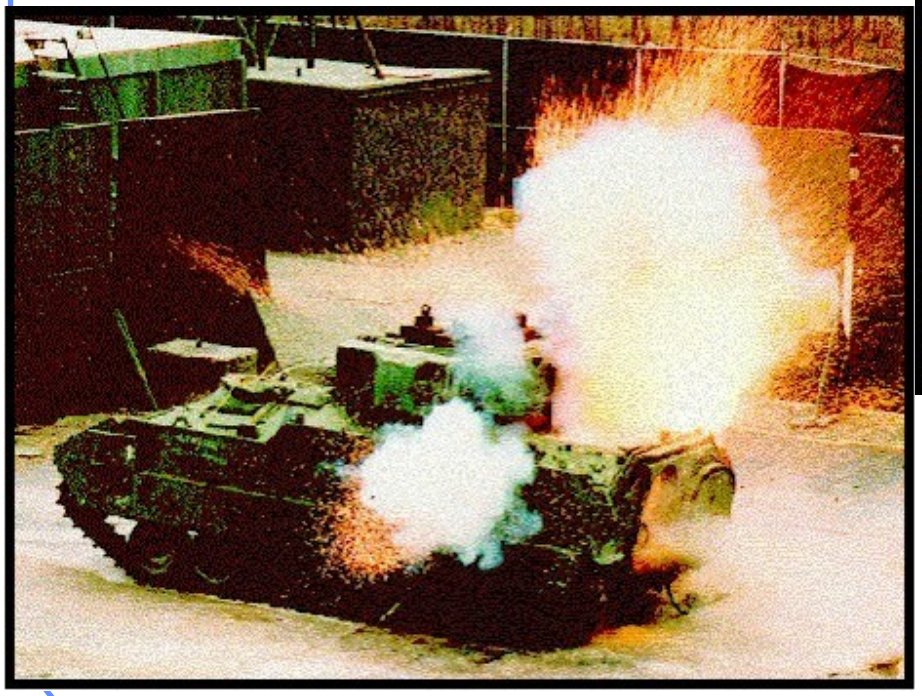


H + 7

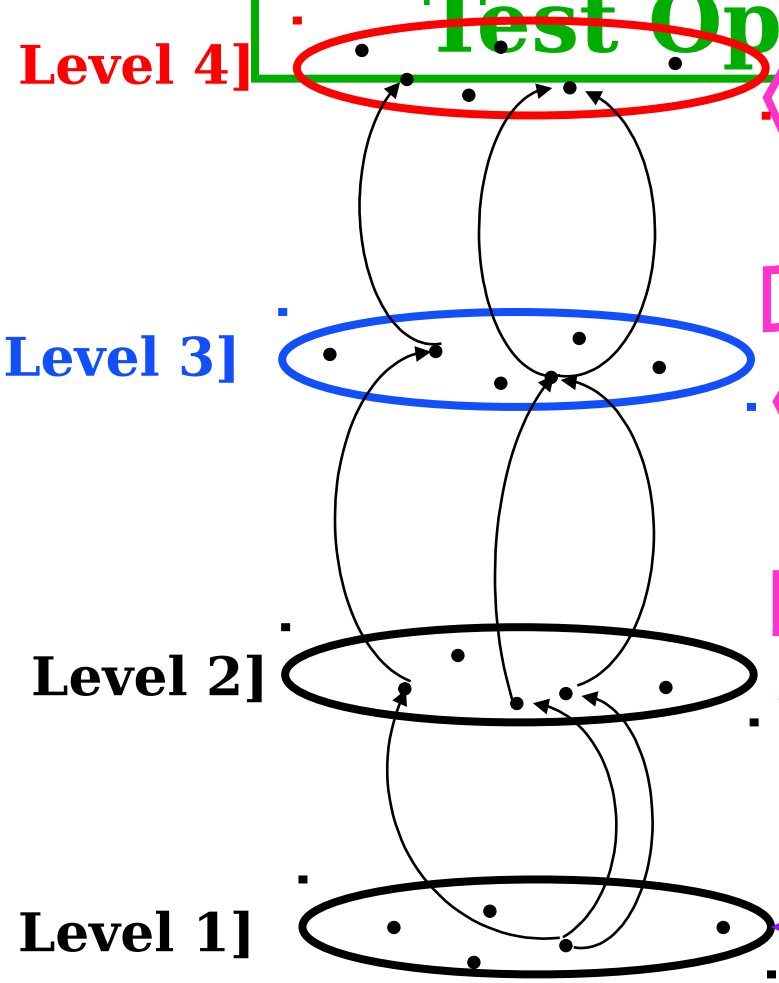
$O_{2,3}$ Operator

Level 2]

Physical Analogues for the $O_{1,2}$ Operator



Abstraction: Platform Live-Fire Test Operator



$O_{3,4}$ Operator

$O_{2,3}$ Operator

$O_{1,2}$ Operator

Military Operations Context

- Tactics
- Doctrine
- Scenario
- etc. (Global Variables)

Context Data

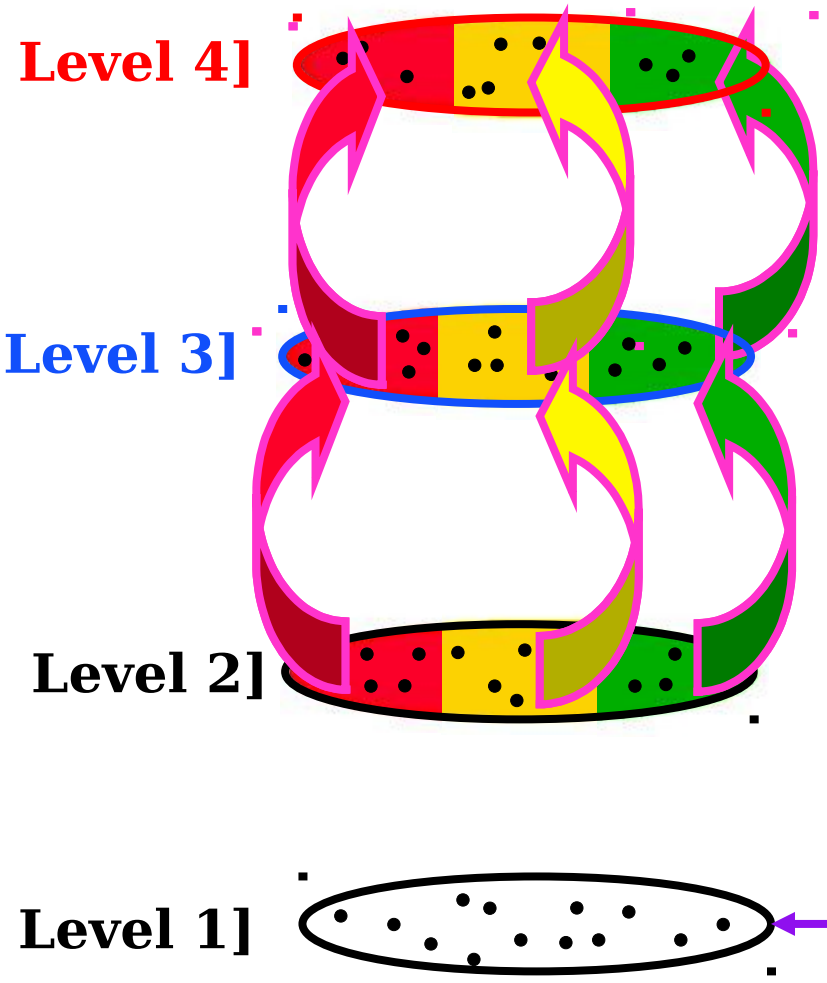
Risk Factors

Component Change Mechanisms

(Quasi-) Perm Damage	Temp Damage	Comp Repair/Fi
Ballistic	Electronic Jamming	Battle Damage
Chemical	Cosite Interference	Resupply/Replenish
Laser		Sleep+
Directed Energy		
High-Pwr Laser		
Nuclear		
Physics of Failure		
Logistics Burdens (Fuel, Ammo)		
Reliability		
Fair Wear & Tear		
Fatigue+		
Heat Stress+		

+ Personnel Related

Mission-Based Utility



Combined Platform Performance

ACQUIRE

ACQUIRE

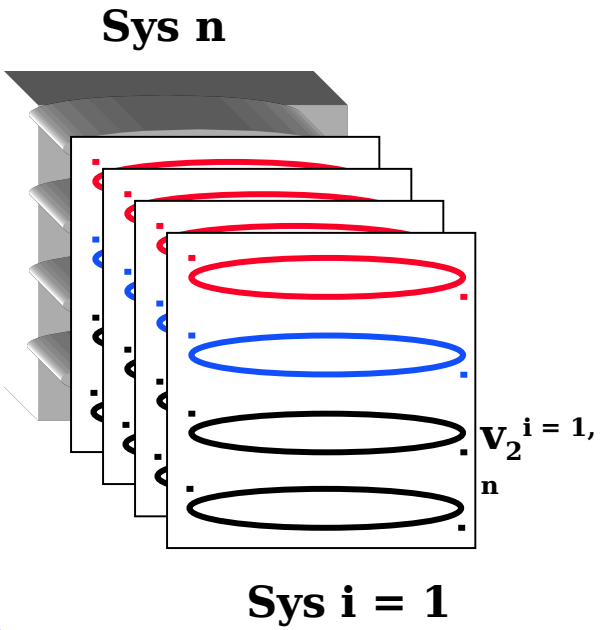
ACQUIRE

COMMO

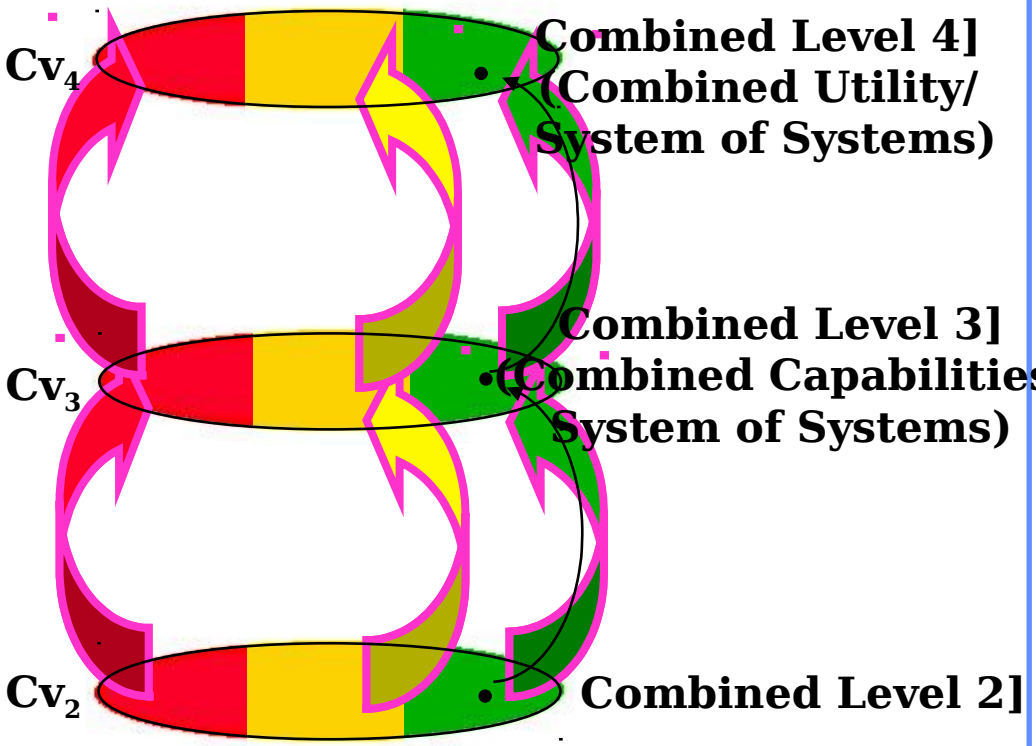
H + 5

ISAA

System-of-Systems



$V_2^{i=1,n}$



Conclusions

- Have described an analysis framework that:
  - has three linked metrics – utility, capability, componentry
  - where utility is based on mission-related capabilities
  - capabilities are based on componentry
  - platform componentry is the <u>fundamental metric</u>, and
  - the linkages include dependencies on specific military mission/context
- Platform effectiveness can change with time as:
  a] mission requirements change, and/or
  b] the component infrastructure degrades or is reconstituted

Conclusions (cont)

- As a mission proceeds in time, the levels are mapped from the bottom up

- However, to develop an effective platform design, the process must be reversed so as to begin with the desired mission outcome, then infer the relevant capabilities, etc.

- To develop a system-of-systems, an inverse inferencing process must begin with a concept of <u>combined platform utility</u>, then <u>combined platform capabilities</u>, then <u>combined platform component linkages</u>, etc.

Military Utility: Generating Relevant Criteria For Systems Design, Testing, and Analysis

Dr. Paul H. Deitz, Technical Director

U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-TD
Aberdeen Proving Ground, MD 21005-5071
DSN 298-6598, (410) 278-6598, phd@arl.mil
http://amsaa-web.arl.mil/OTD/techdir.html

28 March 2000

Presented at the 11th Annual U.S. Army Ground Vehicle Survivability Symposium, held at the Naval Post Graduate School, Monterey, CA, March 27-30, 2000.

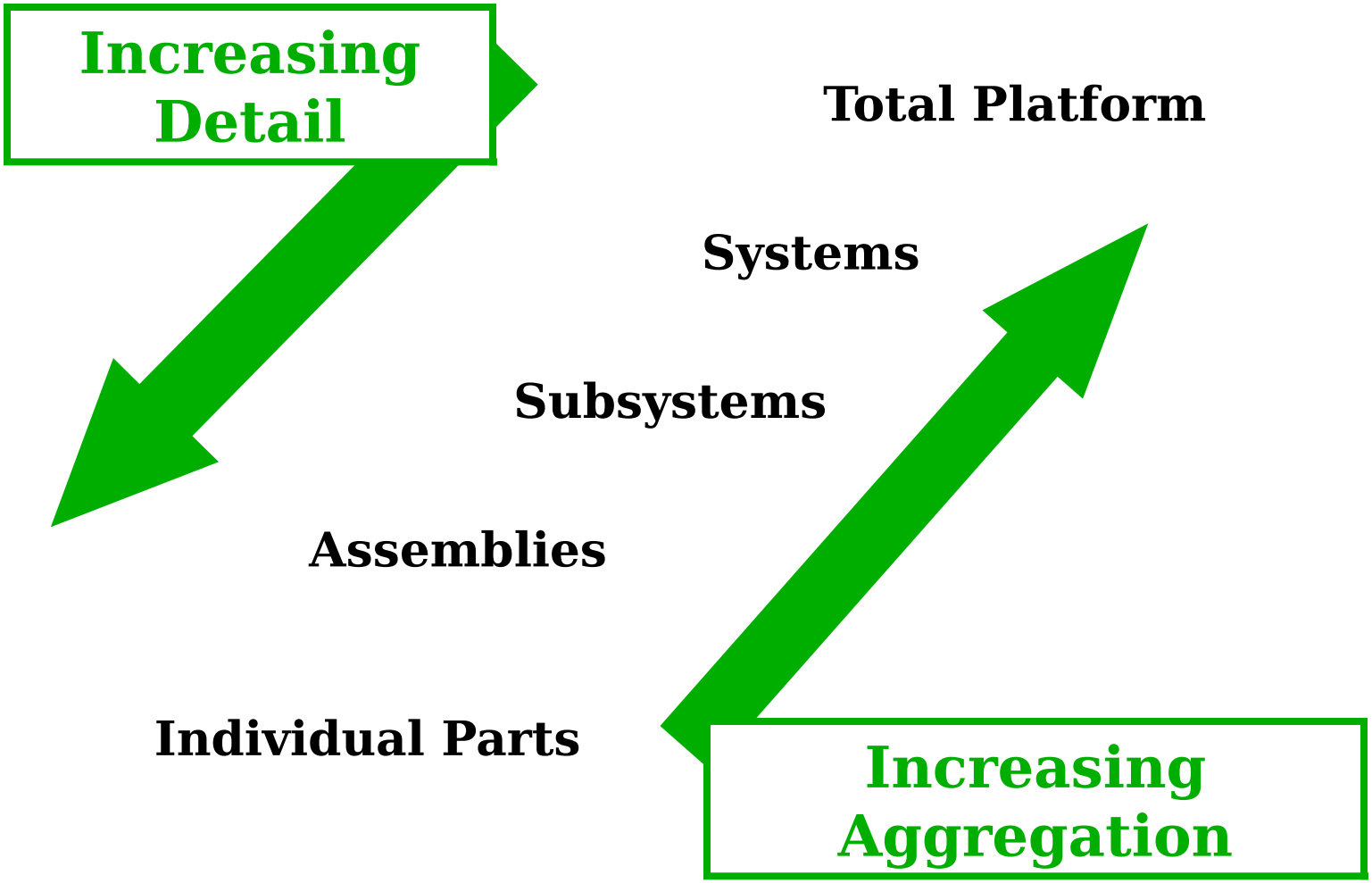
AMSAA

References

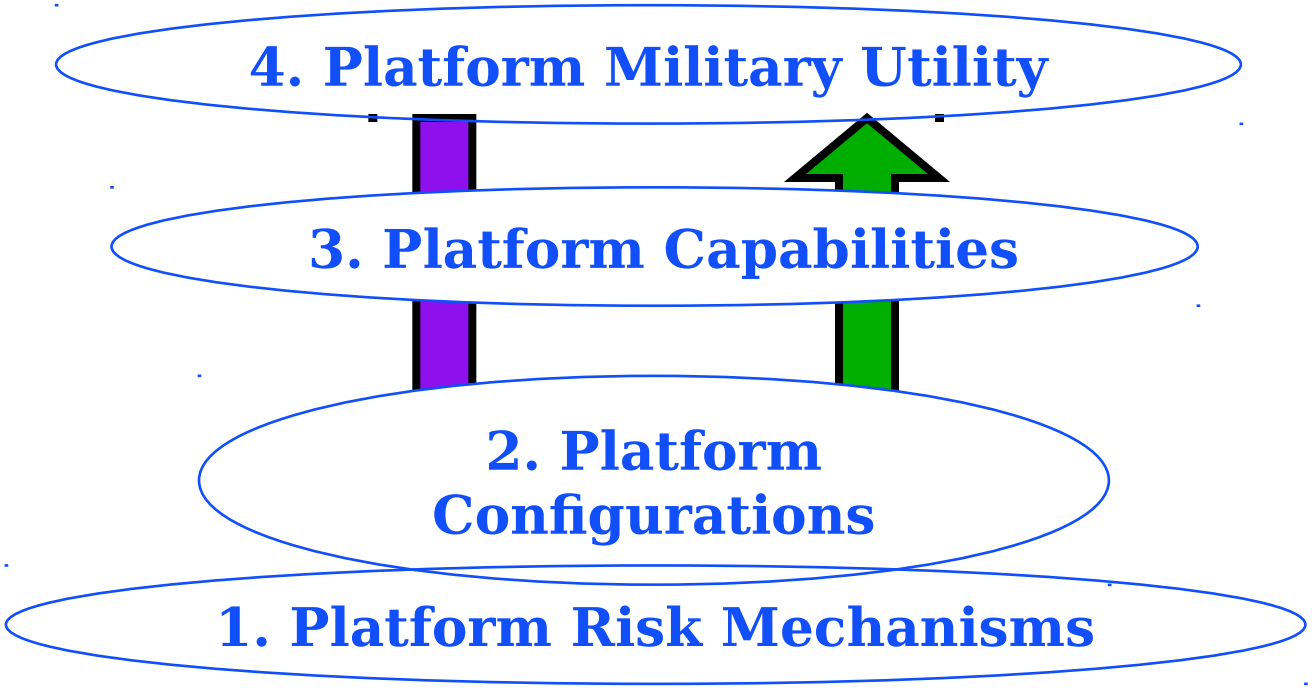
- P. H. Deitz, *A V/L Taxonomy for Analyzing Ballistic Live-Fire Events*, **Proceedings of the 46th Annual Bomb & Warhead Technical Symposium**, 13-15 May 1996, Monterey, CA; also US Army Research Laboratory Technical Report ARL-TR-1274, December 1996.
- P. H. Deitz and M. W. Starks, *The Generation, Use, and Misuse of 'PKs' in Vulnerability/Lethality Analyses*, **The Journal of Military Operations Research**, **Vol. 4**, No. 1, 1999.
- F. Haddix, *The Conceptual Models of the Mission Space (CMMS) Data Representation and Interchange Specification*, **Proceedings of the 1999 Fall Simulation Interoperability Workshop**, sponsored by the Simulation Interoperability Standards Organization, September 1999.
- R. Luman, *Upgrading Complex Systems of Systems: A CAIV Methodology for Warfare Area Requirements Allocation*, **66th Military Operations Research Society Symposium**, Working Group 26, 24 June 1998.
- E. L. DuBois, W. P. Hughes, and L.J. Low, *A Concise Theory of Combat*, **Institute for Joint Warfare Analysis**, Naval Postgraduate School, 1999.
- P. H. Deitz, *Parsing SMART: What Are the Pieces and How Do*

Backups

Structuring Level 2]



Top-Down Decompositional Framework



Bottom-Up Analysis Framework

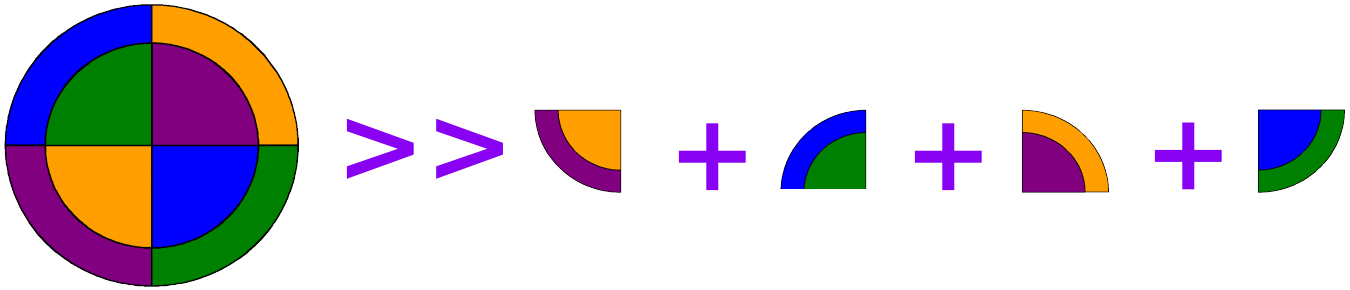
Bottom-up process follows causal (*i.e.*, time-forward) behavior

Audience Survey?

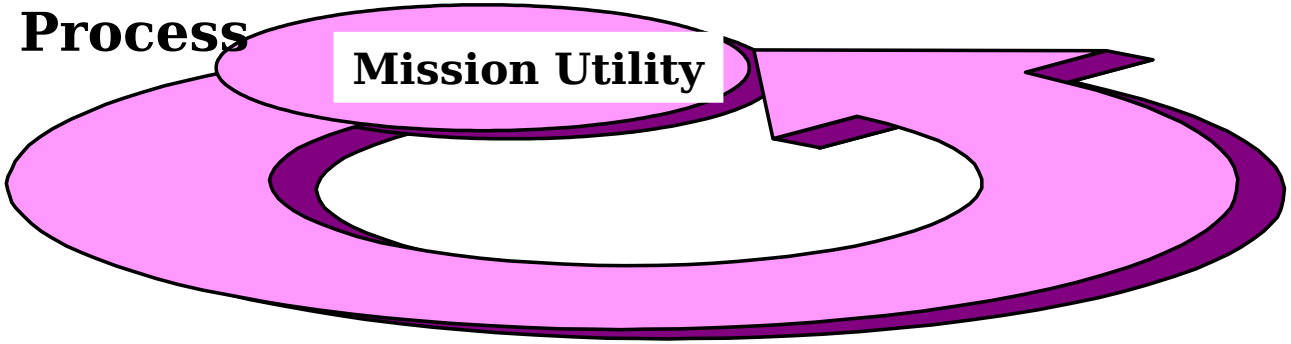
- How many attendees are from the damage or repair community?
- How many are from the single-platform performance community?
- How many are from the multi-platform performance community?
- How many are from the military effectiveness community?
- How many are familiar with at least two of the areas?
- How many are familiar with at least three

Conclusions (cont)

- **With an instantiated environment -**



- **Process**



- **Mission Utility**

Platform Technology

- **Applicable to "Systems-of-Systems" *e.g.***

<u>Communication Systems</u>

- **Provides structure for C/B, CAIV, and AoA analyses**